Energy Efficiency & Conservation Strategic Planning

ESPM 4041W: Problem Solving for Environmental Change

Report 1/8 Prepared for the City of Shoreview by:

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December 17, 2009

University of Minnesota

Table of Contents

List of Figures

List of Tables

Acknowledgements

Our team would like to thank the many individual and organizational contributors without whose enthusiasm, knowledge, and efforts this document would not be complete.

Key contributors include:

Gary Chapman- Building and Grounds Superintendent, Shoreview, for identifying mechanical upgrades and current energy efficiency projects completed by Shoreview in the City Complex, and for giving us a tour of the City Complex site.

Clayton Dumcum- Project Development Engineer, Johnson Controls, for his help interpreting B3 data.

Jenna Williams- Coordinator, Career and External Communications, University of Minnesota Department of Forest Resources, for her valuable feedback on our Residential Energy Efficiency pamphlet.

Tom Hammitt- Senior Engineering Technician, Shoreview, for supplying maps, pictures, resources, and energy use data for the City's streetlights.

Tessia Melvin- Assistant to the City Manager, Shoreview, and her staff, for providing us with B3 data.

John Olson- Owner, Signature Lighting, for his technical expertise about streetlight fixtures and knowledge of other LED street lighting projects taking place in the Midwest.

Jennifer Abbot- Xcel Streetlight Representative for Shoreview, for clarifying streetlight billing and service meter rates.

Madonna Rykken- Business Solutions for the Public Sector, Johnson Controls, for explaining energy efficiency project financing at the municipal level.

Kyle Thompson- Account Executive, Johnson Controls, for his expertise in building efficiency and cooling systems.

Tom Wesolowski- Assistant City Engineer, Shoreview, for presenting an initial overview of the street lighting upgrade project.

Brad Cobb- President, University of Minnesota Active Energy Club.

Adam Kokotovich- ESPM 4041W Teaching Assistant and Energy Team Aid.

Dr. Kristen Nelson- Team Manager and Professor.

Dr. Gary Johnson- Professor.

Executive Summary

Shoreview officials are interested in creating a more sustainable community by working toward energy efficiency goals in both their public and private sectors. With potential carbon and greenhouse gas emissions foot-printing and reporting looming in the future, the time is now for Shoreview to focus on taking strides to decrease their overall energy consumption. This project was completed by seniors in the Environmental Science, Policy and Management degree program at the University of Minnesota in partnership with Shoreview staff. We focused on identifying energy conservation and efficiency strategies for Shoreview by examining the energy use patterns of city streetlights, the Shoreview City Hall/ Community Center Complex, and residents.

Shoreview is considering changing the streetlights in the city to more efficient LED fixtures. We conducted streetlight upgrade cost/benefit analyses by evaluating a number of scenarios based on energy cost savings, maintenance cost reductions, upgrade costs, and carbon emission reductions. Interest in increasing the energy efficiency of the City Complex to serve as a model for residents and other communities prompted an analysis of the building's current energy use trends. We conducted an inventory of Shoreview City Complex energy use data from B3 data and graphically analyzed it to demonstrate consumption trends, costs, and carbon output estimates, as well as where improvement options exist. Lastly for residential energy efficiency, as determined by a household survey, Shoreview residents are committed to decreasing their energy consumption, but perceive costs and difficulty will be barriers to the completion of energy efficiency projects in their homes (Nelson et al. 2008). Accordingly, the city needs an outreach program geared toward residential energy efficiency options and funding sources**.**

Recommendations

We propose the following recommendations to increase the energy efficiency of Shoreview:

- Negotiate a flat rate for LED electricity prices with Xcel Energy and the Public Utilities Commission.
- Monitor LED fixture prices and integrate LED upgrades into the maintenance schedule to replace city-owned 175 watt Mercury Vapor (MV) streetlights.
- Order a formal energy audit of the Shoreview City Complex to identify and prioritize retrofit and improvement opportunities that will reduce energy use and operating costs.
- Upgrade current electric water-cooled chiller at Shoreview City Complex to a more efficient model.
- Explore financing options and technologies for energy efficiency projects in public buildings.

- Distribute pamphlet of energy efficiency strategies and funding options to Shoreview residents.
- Reduce homeowner perception of barriers to residential energy efficiency through multimedia methods.
- Distribute pamphlet of energy efficiency strategies and funding options to Shoreview residents.
- Integrate residential energy efficiency projects and funding options into the Shoreview public website to engage a wider audience.

Introduction

Concerns over a sustainable future are heightened worldwide as fuel costs and demand fluctuate, world oil production dwindles, and agreement grows that increasing atmospheric carbon levels cause climate change (Solomon et al. 2009). As a community works to increase sustainability, public and private sectors share a genuine commitment to reduce their current energy use and protect their future. A sustainable future is one that meets the needs of the present generation without compromising the ability of future generations to meet their needs, by addressing economic, social, and environmental components of energy use (World Commission on Environment and Development 1987). Living standards that go beyond the basic minimum are sustainable only if consumption standards everywhere plan for long-term sustainability (World Commission on Environment and Development 1987). Most importantly, it will require commitment from citizens around the world to conserve energy and shift to renewable energy sources in order to combat rising fuel costs and lasting environmental damage. Municipalities and citizens are building a movement across the United States, working together for energy independence, a decrease in fossil fuel use, and a tangible response to the imminent threat of climate change.

At present, the United States is one of many countries without a contingency plan for the end of oil production or an effective coping strategy for the impending effects of global warming on environmental factors such as falling water tables, possible species extinctions, and human health risks (Brown 2008; Corvalan et al. 2005). With time, climate change has become a bipartisan issue, stressing the need for political leaders who understand and value the inherent ties between economic growth, environmental protection, and social equity. Leaders at all levels, from federal to municipal, have pledged to solve the climate crisis and support grassroots movements to empower change. It is clear that the United States is transitioning to increased energy conservation and clean, renewable energy sources.

Minnesota has been a leader in energy conservation and alternative energy sources in recent years, and the state continues to strive to lower the statewide carbon output by increasing citizen awareness of energy consumption and options for alternative energy (Taylor 2008). Recently, Governor Tim Pawlenty released the Next Generation Energy Initiative with an ultimate goal of decreasing the State's carbon emissions from energy usage (Minnesota North Star 2006). In addition, the governor led the initiative to encourage "Minnesotans" to take a stake in the energy reduction process. The governor wants the state to understand that not only does saving energy improve communities in Minnesota, but it is critical in boosting the state's economy. Minnesota also decided to allocate the majority of the money awarded to the state, through the Department of Energy's Efficiency and Conservation Block Grant (EECBG) program, to help local communities decrease the energy consumption of their government-owned buildings. The money is awarded strictly for energy efficiency projects including lighting upgrades, more efficient windows, energy recommissioning, and other related projects which are ripe for implementation (US Department of Energy 2009).

The Science Is In

So, what's the big deal? What is climate change and why should we care? Climate change is the result of 200 years of burning fossil fuels, such as coal and oil, causing increased concentrations of heat-trapping "greenhouse gases" (GHGs) in our atmosphere (US Environmental Protection Agency 2009). Have you ever been in a greenhouse in the summertime? It is HOT! Comparably, these gases function like the glass panels of a greenhouse, trapping heat and preventing it from escaping into the atmosphere. According to National Oceanic and Atmospheric Administration (NOAA) and National Aeronautics and Space Administration (NASA) data, the Earth's average surface temperature has increased by approximately 1.2 F to 1.4 F in the last 100 years (US Environmental Protection Agency 2009). The eight warmest years on record (since 1850) all occurred after 1998, with 2005 being the warmest year. Most of the warming in recent decades is very likely the result of human activities (Intergovernmental Panel on Climate Change 2007). The way we live, work, and play is dependent on energy consumption which produces carbon and GHG emissions. In order to continually improve our quality of life, this needs to change (US Environmental Protection Agency 2009).

Why Shoreview?

Shoreview is at a crossroads. An affluent, well-educated community, Shoreview is already fostering ideas for a sustainable future. For these aspirations to reach their full potential, continued progress is paramount. Energy efficiency will be fundamental to achieving the community's goal of a sustainable future.

Shoreview already boasts several activities designed to achieve its energy conservation goals. For example, Shoreview's commitment to sustainable energy usage is evidenced in its high-efficiency street lighting pilot project, where two neighborhoods are aglow with higher-efficiency bulbs; one with 50 watt Light Emitting Diode (LED) bulbs and another with 100 watt high pressure sodium bulbs. Both types of bulbs operate at a lower wattage, making them more economically and environmentally efficient than the traditional 175 watt metal halide or mercury vapor bulb (US Department of Energy 2009). Because these street lights use less energy, they produce fewer carbon emissions and provide greater financial savings.

Such a change could affect everyone in the community. Homeowners will see the changes made by their city officials and, ideally, model their own behaviors after the successful city initiatives. Together, residents, city officials and businesses can save on energy costs and benefit from planning for a more sustainable future.

In fall 2009 Shoreview partnered with senior students from the University of Minnesota's Environmental Science, Policy and Management undergraduate program. The class undertook eight unique but connected projects: alternative energy, wetland communication, wetland education, wetland policy and best management practices, landscape-level environmental policy and planning, urban vegetation assessment, urban canopy assessment, and two groups focused on the sustainability of parks. In this report we focused on improving energy efficiency in Shoreview. We evaluated the city's energy efficiency and made recommendations for improvements.

Vision Statement

We envision a sustainable Shoreview: a city that balances social equity, economic vitality, and environmental integrity to maintain and improve the quality of life for current and future residents. We aim to further enable Shoreview by:

- Providing relevant tools and information,
- Encouraging an active and aware citizenry,
- Addressing perceived barriers to action, and
- Fostering responsible and collaborative resource management.

Our project strives to empower sustainable behavior and policy changes that will establish Shoreview as a model for other communities.

Goal Statement

The project goal is to identify and analyze areas for energy conservation and efficiency for the city of Shoreview, in order to save money, decrease dependence on greenhouse gas (GHG)-causing fossil fuels, and proactively address the growing challenges of climate change.

Objectives

To realize this goal our team has outlined the following objectives:

- Evaluate the feasibility of two energy efficient streetlight upgrade options.
- Gather information and assess the energy efficiency of the Shoreview City Complex.
- Analyze resident perceptions and behaviors regarding energy conservation and efficiency in the home.
- Provide funding options and resources for municipal and residential energy efficiency projects.

Methods

Site Description

Shoreview is a second-ring suburban community located on the northeast side of the Twin Cities Metropolitan area in Minnesota. It is approximately ten miles north of St. Paul in the northwest corner of Ramsey County, at the intersections of major transit routes. The western border in north-southbound Interstate 35W and Lexington Avenue bisects the city north and south. Interstate 694 runs through the southern section of Shoreview and Highway 96 transects the city east and west. Nine cities share a border with Shoreview. Shoreview land use is largely low-density residential development, with the small commercial sectors found along major transportation corridors (Figure 1).

Shoreview spans an area of 8,162 acres, about 41% of which comprises 11 lakes, ten parks, and abundant wetlands and open space. The city is 99% developed and offers an array of residential housing options, sport and recreational opportunities, along with a humble local business community; it consistently ranks as one of the best areas to live in the metro area (City of Shoreview 2009).

In the 1970s and 1980s, the population of Shoreview increased dramatically. Today, there are approximately 27,000 residents, and future projections indicate a stable population base (US Census Bureau, 2007). Approximately 96% of residents are high school graduates over the age of 25 and 46.9% hold a bachelor’s degree or higher (US Census Bureau 2007). There is a notable population of older residents in Shoreview; approximately 9.7% of the population is over the age of 65. Many of Shoreview’s residents have lived in the city for an extended period of time, with over 63% of Shoreview residents have been living in their home for more than five years (US Census Bureau 2007).

Located in the heart of the city, the Shoreview City Complex building joins the City Hall and Community Center (Figure 1). The City Hall houses the daily operations of the City’s five government departments: Administrative, Finance, Parks and Recreation, Public Works, and Community Development. The Community Center provides several amenities, including an indoor water park, a bi-level fitness center, meeting and banquet rooms, sports fields, and a maintenance garage for city equipment. In 1990, the city built the 70,000 square-foot Community Center, which was later expanded in 2003 (City of Shoreview 2009).

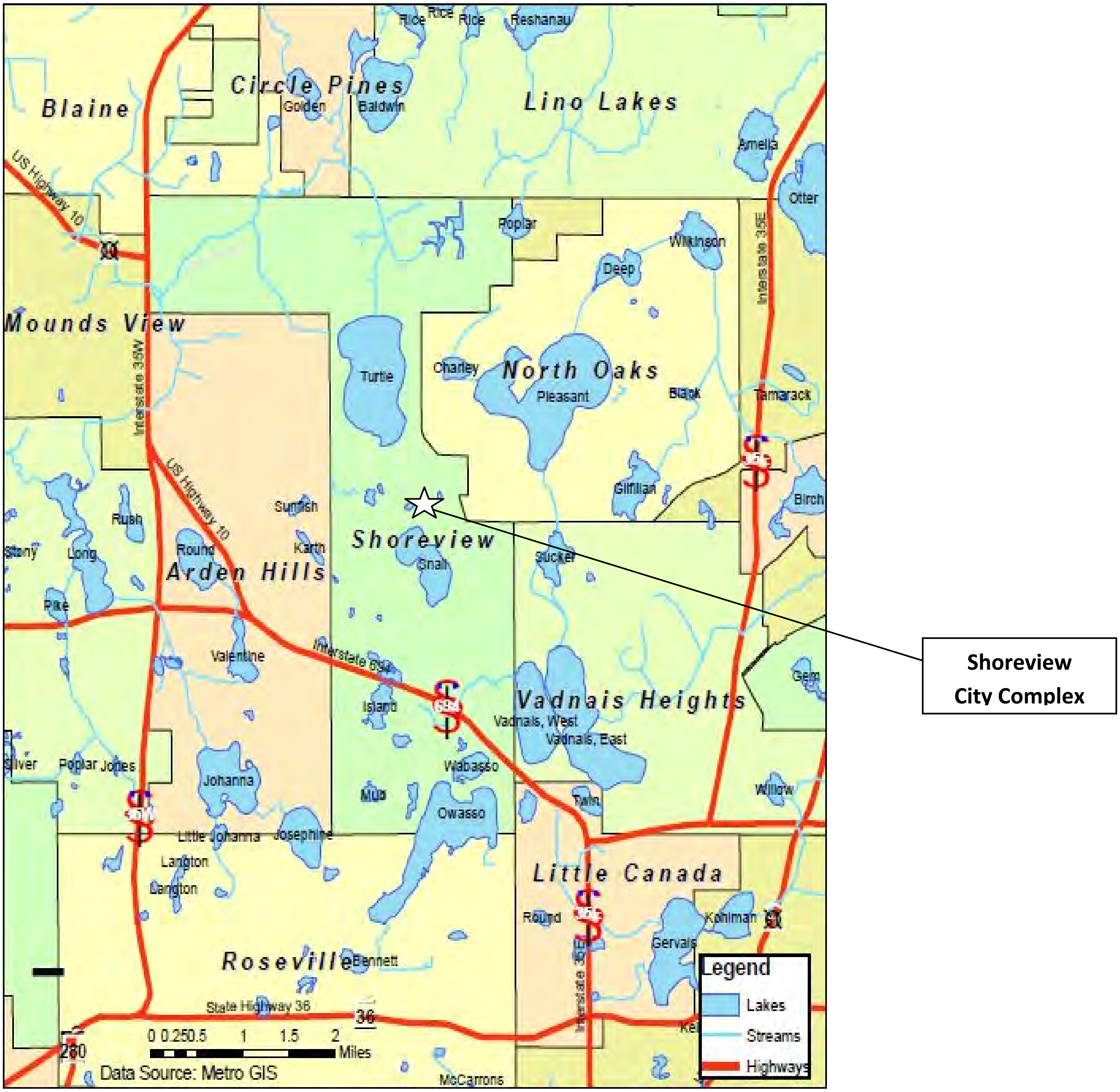

Figure 1. Map of Shoreview, Minnesota and surrounding communities, including lakes, and major highways (Johnson et. al, 2009).

Research Techniques

We used several methods to assess Shoreview's energy consumption and identify areas for potential improvements. These activities included an assessment of city-owned streetlights, an inventory and analysis of energy use data in the Shoreview City Complex, and an analysis of data from a survey of Shoreview Residents.

Street Light Assessment

We assessed the feasibility of replacing the current MV bulbs with HPS or LED bulbs, both with lower wattages. We did a cost-benefit analysis to determine the potential for energy reductions, carbon emission reductions, and the payback period for each streetlight type. We performed several calculations to determine the cost savings of current technologies and more efficient LED fixtures, using information provided by Xcel Energy, Shoreview Senior Engineering Technician, Tom Hammitt, the city's primary lighting consultant, John Olson of Signature Lighting, and Philips Company, the LED fixture vendor. We gathered information for each lighting technology, including: fixture wattage, estimated lifespan, cost per fixture, operating hours per day, maintenance and relamping costs, and price per kilowatt-hour of electricity. Based on the price per kilowatt hour provided by Xcel Energy and the average number of hours per day that the streetlights operate, we determined the cost of electricity per day and calculated the annual payback. We performed several payback scenarios varying the type and number of streetlights being upgraded, inclusive or exclusive of the metering service charge from Xcel Energy. We also calculated the annual carbon emissions reductions utilizing factors calculated by the US Environmental Protection Agency (US Environmental Protection Agency 2009).

Inventory of Energy Use Data

A Minnesota state legislative initiative passed in 2001 charged all managers of publicly owned buildings with the task of gathering building and energy consumption data to evaluate the performance of the building, and identify areas for energy efficiency improvements (Minnesota Department of Administration 2002). The Minnesota Department of Administration subsequently developed a database called, "B3: Buildings, Benchmarks, and Beyond," where building managers can submit energy use data for a building or site which is then *benchmarked*, or compared with a computer model of itself built to state energy code (Minnesota Department of Administration 2009). We gathered this data for the Shoreview City Complex into a workable spreadsheet for the City of Shoreview. Next, we analyzed the City Complex data to identify areas of energy consumption, costs, and carbon output estimates, as well as where improvements could be made. In doing so, we also examined specific opportunities for mechanical upgrades and other efficiency measures within the building.

Analysis of Social Survey Data

To determine the level of public concern for environmental issues and energy consumption, as well as perceptions about increasing energy efficiency, we analyzed secondary data from a survey administered by a University of Minnesota research team (Nelson et al. 2008). The survey, titled ***Our Household Choices in Urban Living***, contained specific information regarding residential energy use. The survey was conducted in Anoka and Ramsey Counties during the spring and summer of 2008 and was funded by the National Science Foundation (Biocomplexity Project EAR-0322065). A randomized selection of approximately 15,000 residents, based on land-line phone numbers and census blocks, received the survey, of which 109 were Shoreview residents.

The questions that we analyzed for this project were chosen based on relevance for residential energy efficiency in Shoreview (Appendix A). We tabulated the relevant data into tables and graphs. This analysis identified challenges and opportunities for increasing energy efficiency at the residential level.

Findings

Streetlight Cost/Benefit Analysis

The City of Shoreview currently owns 125 Mercury Vapor (MV) streetlights which are 20-30 years old and less energy efficient than the 483 city-owned High Pressure Sodium (HPS) streetlights installed over the last 15-20 years (Figure 2). The current city practice is to install a HPS streetlight if a MV streetlight breaks, because the MV technology is so outdated that few MV fixtures are sold anymore. The city recently replaced 5 MV streetlights with 5 Light Emitting Diode (LED) streetlights as a pilot project to evaluate the economic viability of installing them on a larger scale in the future.

A calculation of the energy usage for the city's three streetlight technologies reveals that LED streetlights use much less energy than HPS streetlights. MV streetlights use more energy than HPS streetlights, so switching from a 175W MV streetlight to a 50W LED streetlight offers the most energy use savings. A 50-watt LED streetlight uses approximately 30% of the energy that a 175-watt MV streetlight uses, whereas a 100-watt HPS streetlight uses approximately 63% (Table 1). If all three streetlight technologies were billed in the same manner, charging the current rate per kWh of electricity usage ($.06705/kWh), each 50W LED would save $29.52 over a 175 MV. But currently, HPS and MV streetlights are charged a flat monthly rate per light based upon historical data of average monthly energy usage. LED streetlights are metered and charged by the kWh because a flat rate has not been established by Xcel Energy since they are such a new technology (Appendix B).

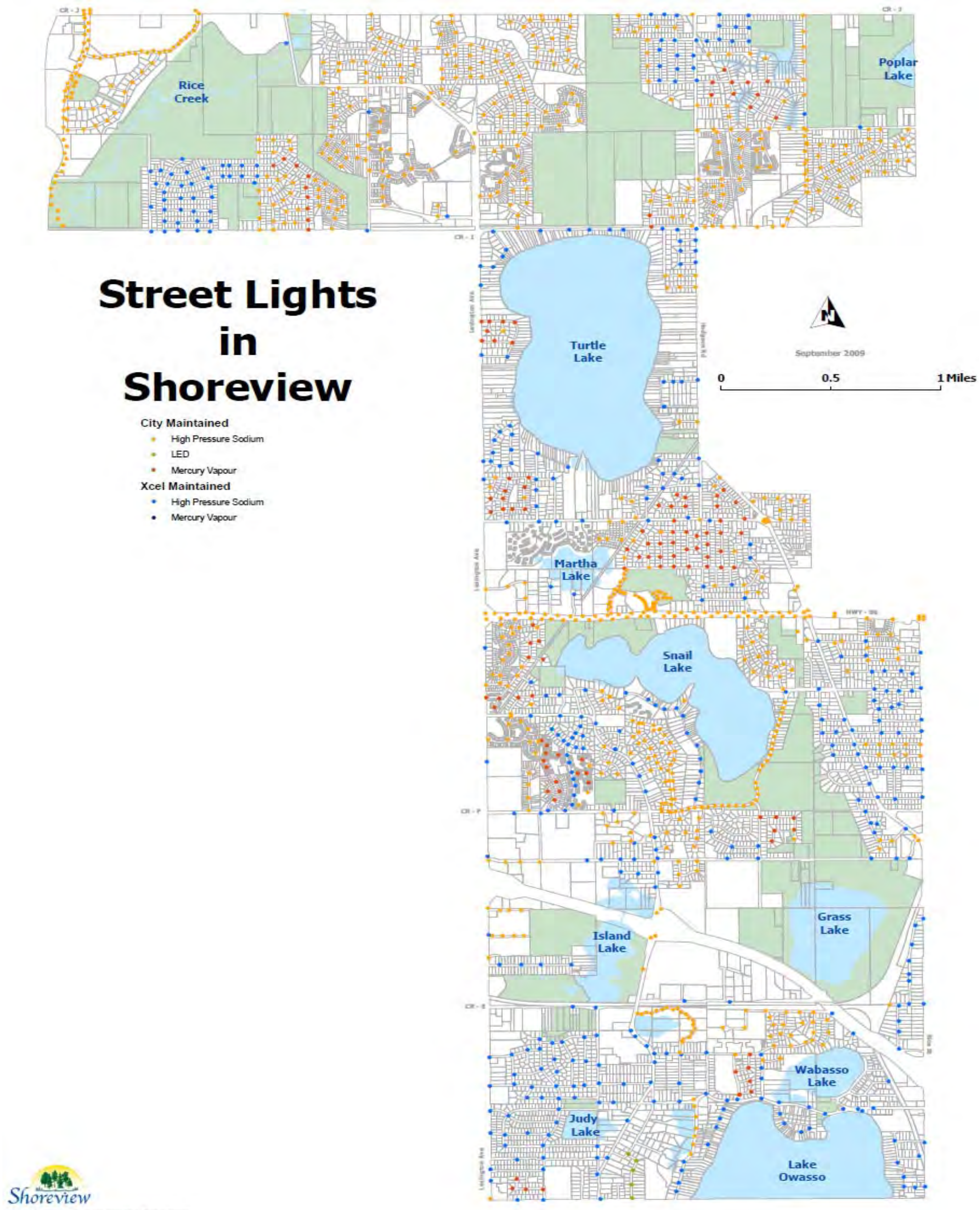

Figure 2. Map of streetlights in Shoreview (Shoreview Engineering Department, 2009).

Table 1. Estimated electricity usage, cost and carbon emissions of one streetlight, by type (assuming all streetlights are charged $.06705/kWh), Shoreview, Minnesota, 2009.

Streetlight Type (one streetlight)	**50W LED**	**66W LED**	**100W LED**	**100W HPS**	**175W MV**
Total watts consumed (W)	56.00	69.00	104.00	120.00	190.00
Average usage/day (Hrs)	9.00	9.00	9.00	9.00	9.00
Annual electricity usage (kWh)	183.96	226.67	341.64	394.20	624.15
Annual electricity usage (as % of MV usage)	29.47	36.32	54.74	63.16	100.00
Annual electricity cost ($)	12.33	15.20	22.91	26.43	41.85
Annual carbon emissions (metric tons CO_2)	0.13	0.16	0.25	0.28	0.45

For use along residential city blocks, light (lumens) emitted from each type of fixture meet the lighting needs of such an area, and each type of fixture could be used interchangeably throughout most residential areas of Shoreview. Some areas such as street intersections and busy city streets require more light than can be provided by some of the LED options.

In addition to potential energy savings, LED streetlights also reduce expenses for the city by requiring less maintenance. LED streetlights are predicted to last 15-20 years without any maintenance, whereas HPS and MV streetlights require relamping maintenance every 4-5 years. The city incurs a variety of relamping costs such as purchasing new bulbs, labor for an electrician, and bulb disposal (Appendix B).

On top of these money saving opportunities, LED streetlights also offer a large environmental benefit with respect to climate change by using less electricity. Replacing a 175W MV streetlight with a 50W LED would reduce the carbon emissions from producing the electricity to power that light by 70%. Replacing all 125 of the city-owned 175 MV streetlights in Shoreview with 50 watt LEDs would reduce the city's annual carbon emissions by 40 metric tons (Table 2). This is equivalent to the annual emissions of 3.6 single-family homes or the annual carbon emissions of 7.7 passenger vehicles (US Environmental Protection Agency 2009). Likewise, replacing all 483 100W HPS streetlights with 50W LEDs would reduce the city's carbon emissions by 72 metric tons, the equivalent to the annual emissions of 6.4 single family homes or 13.8 passenger vehicles (Table 3) (US Environmental Protection Agency 2009).

Although LED streetlights create a number of money saving opportunities and environmental benefits, there are also a number of economic challenges associated with them. Foremost, LED fixtures currently cost $985, nearly four times the price of HPS fixtures, which cost $225. In addition, 50W LEDs have the largest annual electricity cost savings when compared with 175W MV, approximately $30 per streetlight (Appendix B). Due to the high price of the LED fixture, the payback period for upgrading from a 175W MV streetlight to a 50W LED, accounting for savings from reduced maintenance, is roughly 36 years (Table 2). The city's current practice of replacing broken 175W MV streetlights with 100W HPS lights results in a 27 year payback. The upgrade cost for a 50W LED is roughly 3.2 times that of a 100W HPS, but it also has an annual total cost savings that is 3.4 larger. Some predict the price of LED streetlight fixtures to dramatically decrease in price once they begin to be mass produced. If the price of a 50W LED fixture were to decrease by 50%, the payback period for upgrading a 175W MV light would decrease to 20 years (Appendix C).

Table 2. Estimated payback period and carbon emission reductions from upgrading all city-owned 175W MV streetlights (125 lights), ignoring meter service charge, Shoreview, Minnesota, 2009.

Streetlight Type (upgrading 125 175W MV lights)	50W LED	66W LED	100W LED	100W HPS
Annual reduction in electricity usage (kWh)	55,023.75	49,685.63	35,313.75	28,743.75
Annual electricity cost savings ($)	2,970.48	2,639.79	1,749.47	1,395.00
Annual relamping cost savings ($)	816.88	816.88	816.88	211.38
Total annual cost savings ($)	3,787.36	3,456.67	2,566.34	1,606.38
Total upgrade cost ($)	138,125.00	138,125.00	138,125.00	43,125.00
Payback period (yrs)	36.47	39.96	53.82	26.85
Annual reduction in carbon emissions (metric tons)	39.51	35.67	25.36	20.64

Table 3. Estimated payback period and carbon emission reductions from upgrading all city-owned 100W HPS streetlights (483 lights), Ignoring meter service charge, Shoreview, Minnesota, 2009.

Streetlight Type (upgrading 483 100W HPS lights)	50W LED	66W LED	100W LED
Annual reduction in electricity usage (kWh)	101,545.92	80,919.41	25,386.48
Annual electricity cost savings ($)	6,087.66	4,809.87	1,369.66
Annual relamping cost savings ($)	2,339.65	2,339.65	2,339.65
Total annual cost savings ($)	8,427.31	7,149.52	3,709.31
Total upgrade cost ($)	533,715.00	533,715.00	533,715.00
Payback period (yrs)	63.33	74.65	143.89
Annual reduction in carbon emissions (metric tons)	72.91	58.10	18.23

Another major factor that affects the economic viability of LED streetlights is Xcel Energy's billing system. At present, HPS and MV streetlights are billed at a flat rate each month based upon fixture type, wattage, and historical average kWh consumption data (Northern States Power Company 2008). Xcel Energy currently has not determined an appropriate flat rate charge for LED streetlights because they are a very new technology. Therefore, the electricity usage is metered on each light or string of lights and the city is billed on a $/kWh rate, which varies with the season. The major impact of this billing system is that an $8 monthly service charge is assessed for each meter, which dramatically reduces any energy cost savings. This resulting $96 annual charge/meter is much larger than the $30 in total annual cost savings from upgrading a 175-watt MV streetlight to a 50-watt LED streetlight (Appendix B). Under this billing system, the only way an LED streetlight can save the city money is if it is metered on a large string of streetlights; the meter service charge per light decreases as more lights are added to the circuit (Figure 3). Five 50W LED streetlights must be metered together in order to receive any annual electricity savings when replacing 175W MV streetlights (Appendix D). Thus, a 50W LED streetlight on a meter with less than five other lights currently costs more than a 175W MV light even though it uses 70% less energy. Then replacing 100W HPS streetlights, eight 50W LED streetlights must be metered together in order to receive any saving on electricity costs. Taking into account this meter service charge results in a payback period of 99 years for 50W LEDs with five lights per meter and when replacing 175W MV streetlights (Table 4). This meter service charge dramatically decreases the economic viability of upgrading 100W HPS streetlights to LEDs. If a 100W HPS light was upgraded to a 50W LED light and metered with 8 other lights, it would require 202 years to make up the upgrade cost in annual savings (Table 5). Considering the meter service charge makes up such a large portion of the energy costs for LED streetlights, negotiating a flat monthly rate for LED's with Xcel Energy and the Public Utilities Commission would decrease the payback period for upgrading to LED's dramatically.

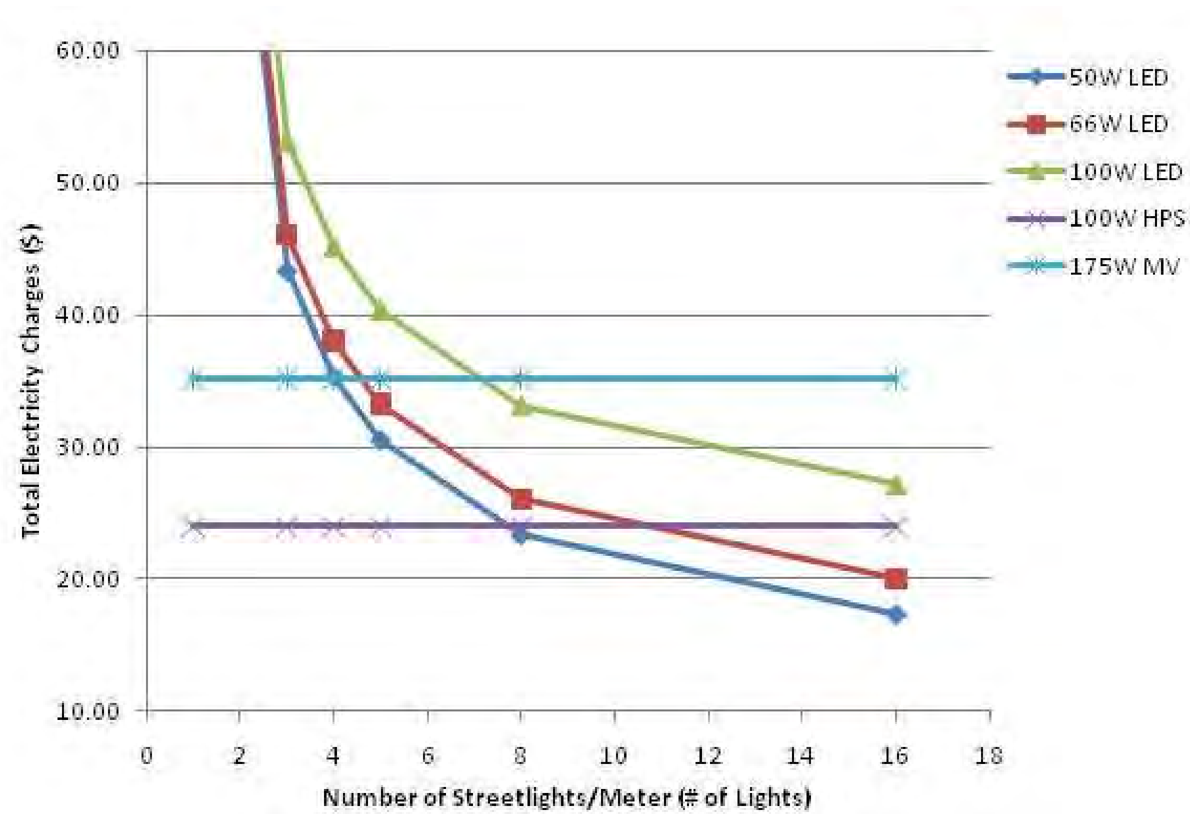

Figure 3: Total annual electricity charges for one streetlight by streetlight type vs. number of streetlights per meter (including meter service charge), Shoreview, Minnesota, 2009.

Table 4. Estimated payback period and carbon emission reductions as a result of upgrading all city-owned 175W MV streetlights (125 Lights), as compared with the number of streetlights/meter, including meter service charge, Shoreview, Minnesota, 2009.

Streetlight Type (upgrading 125 175W MV lights)	50W LED	66W LED	100W LED	100W HPS
Annual reduction in electricity usage (kWh)	55,023.75	49,685.63	35,313.75	28,743.75
Annual electricity cost savings ($) (1 light/meter)	-9,029.52	-9,360.21	-10,250.53	1,395.00
Annual electricity cost savings ($) (5 lights/meter)	570.48	239.79	-650.53	1,395.00
Annual relamping cost savings ($)	816.88	816.88	816.88	211.38
Total annual cost savings ($) (1 light/meter)	-8,212.64	-8,543.33	-9,433.66	1,606.38
Total annual cost savings ($) (5 lights/meter)	1,387.36	1,056.67	166.34	1,606.38
Total upgrade cost ($)	138,125.00	138,125.00	138,125.00	43,125.00
Payback period (yrs) (1 light/meter)	-16.82	-16.17	-14.64	26.85
Payback period (yrs) (5 light/meter)	99.56	130.72	830.37	26.85
Annual reduction in carbon emissions (metric tons)	39.51	35.67	25.36	20.64

Table 5. Estimated payback period and carbon emission reductions as a result of upgrading all city-owned 100W HPS streetlights (483 lights), as compared with number of streetlights/meter, including meter service charge, Shoreview, Minnesota, 2009.

Streetlight Type (upgrading 483 100W HPS lights)	50W LED	66W LED	100W LED
Annual reduction in electricity usage (kWh)	101,545.92	80,919.41	25,386.48
Annual electricity cost savings ($) (1 light/meter)	-40,280.34	-41,558.13	-44,998.34
Annual electricity cost savings ($) (8 lights/meter)	291.66	-986.13	-4,426.34
Annual relamping cost savings ($)	2,339.65	2,339.65	2,339.65
Total annual cost savings ($) (1 light/meter)	-37,940.69	-39,218.48	-42,658.69
Total annual cost savings ($) (8 lights/meter)	2,631.31	1,353.52	-2,086.69
Total upgrade cost ($)	533,715.00	533,715.00	533,715.00
Payback period (yrs) (1 light/meter)	-14.07	-13.61	-12.51
Payback period (yrs) (8 lights/meter)	202.83	394.32	-255.77
Annual reduction in carbon emissions (metric tons)	72.91	58.10	18.23

An important factor to consider with respect to this cost/benefit analysis is that the economic benefits and payback periods do not account for carbon emissions. Carbon emissions are not currently regulated, therefore this study does not consider a cost for the privilege to emit. Upgrading to LED technology would drastically reduce carbon emissions from the city's streetlights which would have a large environmental benefit. For example, if the city upgraded all of the 175W MV and 100W HPS streetlights that it owned it would reduce its annual carbon emissions by 112.4 metric tons of CO_2, equivalent to the annual carbon emissions of 21.5 passenger vehicles.

Energy Efficiency of Shoreview City Complex

An analysis of energy consumption data for the Shoreview City Complex indicates that there are areas for energy savings and carbon reduction. Interviews and a tour of the City Complex with Gary Chapman, Building and Grounds Superintendent, revealed that energy efficiency measures by the city are mostly reactive. Shoreview has used mechanical malfunctions as opportunities to upgrade to more efficient technologies. For example, when a 1,000,000 Btu boiler in the pool area failed, a pair of 500,000 Btu high-efficiency boilers were installed, with controls allowing the city to run only one boiler during marginal times. However, the city is also taking voluntary steps to increase energy efficiency through actions such as switching to LED holiday lights and turning off computers at night.

Energy consumption data over three years shows 2009 has had the lowest overall energy use (kWh); this may be attributed to building improvements, climatic implications and other energy-related fluctuations. An analysis of B3 data for the Shoreview City Complex shows the trends in energy consumption and costs over roughly a three-year period (Figures 4 and 5, Appendix E). As energy costs rise, it is important to look for ways to reduce the energy demand of public buildings and thus taxpayer costs for operating them. As of 2008, the cost to operate the City Complex (exclusive of water) was $3.11/ft^2 (Table 6). The B3 data summary allows building managers to see how their sites and buildings are performing compared to a scientific energy benchmark. The energy benchmark does not compare a building's performance to other comparable buildings in the state, but to a computer engineering model of itself, if the building was built to Minnesota energy code. The B3 summary report notes that the 110,602 square-foot Shoreview City Complex only uses 26% more energy than the engineering model; a considerable accomplishment for a large mixed-use building heating, cooling and lighting to serve various spaces and needs. However, there is still room for energy savings and carbon reduction. Based on the 2008 data, if the City Complex could reduce its electricity use by 30% and its natural gas use by 25%, the operating cost per square foot would be reduced to $2.24/ft^2.

Table 6. Calculated total energy usage, carbon output, and operating cost of the Shoreview City Complex in 2008 (Data source: B3 Database, 2009).

Building size (ft^2)	**Utility type**	**Utility usage (kWh, therms)**	**Carbon output* (metric tons)**	**Utility cost (total)**	**Annual ($/ft^2)**
110,602	Electricity	2,824,200	2,028	$204,666.00	$1.85
	Gas	116,546	583	$139,389.00	$1.26
		Total	**2,611**	**$344,056.00**	**$3.11**

*CO_2 metric tons equivalent to the annual greenhouse gas emissions of 478 passenger vehicles (US EPA 2009).

**the average annual greenhouse gas emission of one passenger vehicle is 5.48 metric tons.

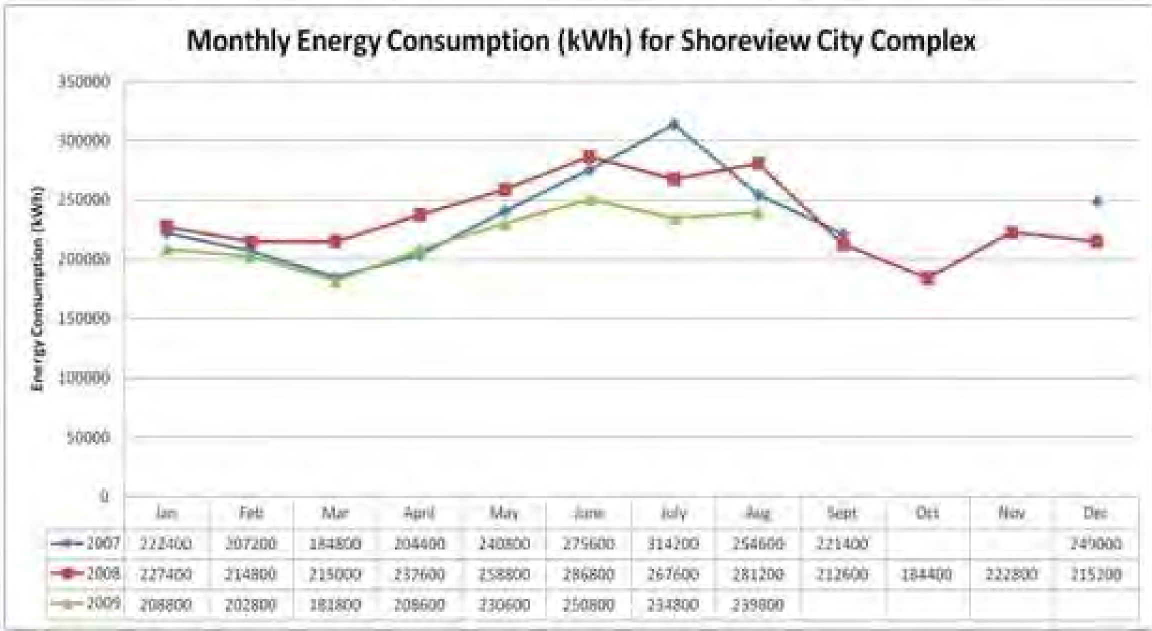

Figure 4. Monthly energy consumption in kilowatt-hours of electricity for the Shoreview City Complex between 2007 and 2009. A key shows the year and total kilowatt-hours for each month. *Missing entries resulted in 2007 and 2009 discontinuous lines (Data source: B3 Database, 2009).

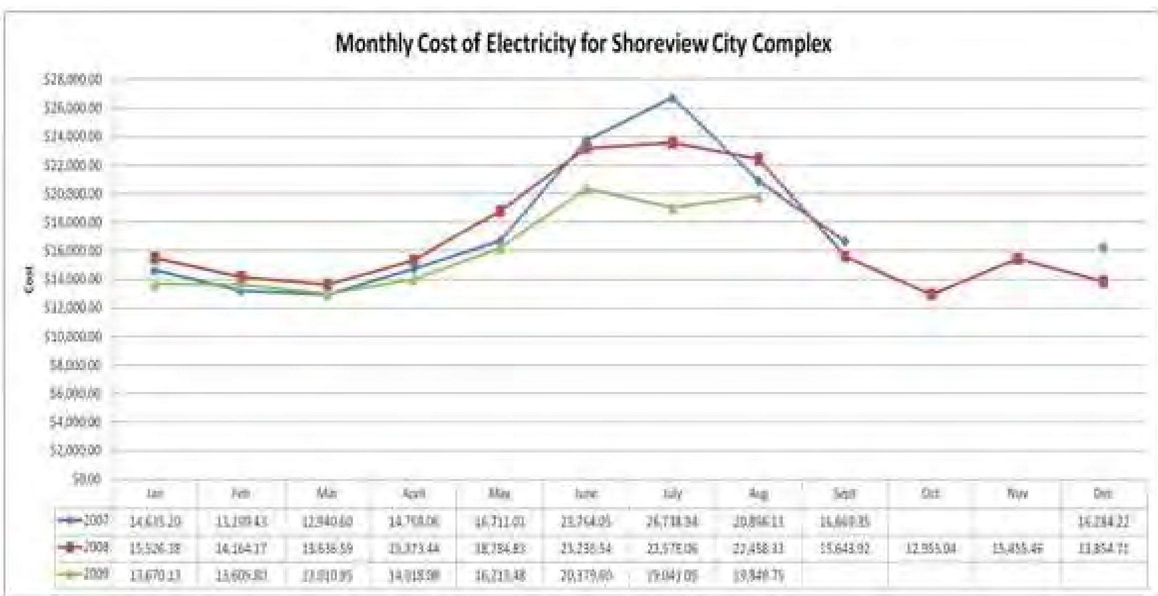

Figure 5. Monthly cost of electricity for the Shoreview City Complex between 2007 and 2009. A key shows the year and the total cost of electricity for each month. *Missing entries resulted in 2007 and 2009 discontinuous lines (Data source: B3 Database, 2009)

The highest energy use and associated costs for the Shoreview City Complex coincide over three years from May to August; one hypothesis is that inefficient cooling technology is causing peak demand charges (Figure 6). The Shoreview City Complex is cooled by a YORK 175-ton electric water-cooled chiller that has not been replaced since the building was constructed in 1990. Energy efficiency of a chiller is measured in terms of electrical use per ton of cooling (kW/ton). High efficiency chillers will have a lower kilowatt per ton ratio indicating that it uses less electricity to deliver the same amount of cooling. “High efficiency” generally indicates models that meet Federal Energy Management Program (FEMP) efficiency standards and exceed American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards (Washington State University Cooperative Extension Energy Program 2003). Gary Chapman estimates that the current chiller’s centrifugal compressor and fans operate at approximately 167.3 kilowatts and 19.2 kilowatts respectively at peak load, together totaling 186.5 kilowatts.

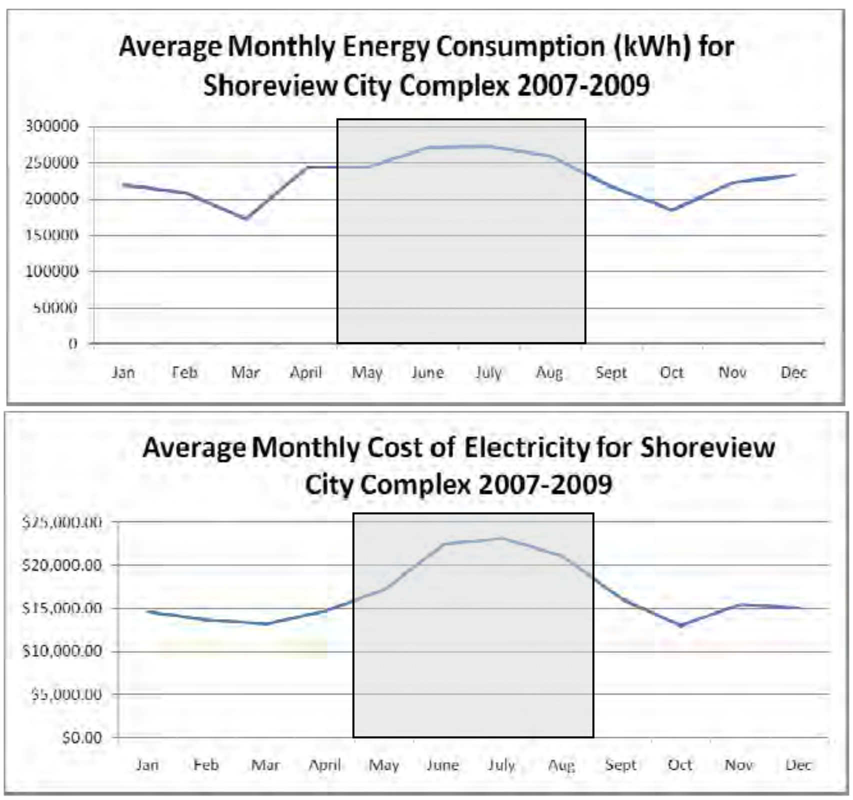

Figure 6. Average monthly energy consumption in kilowatt-hours of electricity for the Shoreview City Complex and the average associated cost per month from 2007 – 2009. The shaded area shows corresponding peaks in use and cost (Data source: B3 Database, 2009).

The full load efficiency of the current chiller is 186.5 kW/175 ton = 1.04 kW/ton. ASHRAE, a professional organization that sets efficiency standards for government and commercial buildings, recommends a full load efficiency of 0.84 kW/ton or less. FEMP recommends higher efficiency levels of 0.59 kW/ton or less. The best available units have a full load efficiency of 0.50 kW/ton. Gary Chapman also estimated that the chiller runs between 14-16 hours a day June through August. Based on this formation, we determined that roughly 30% of the building's average monthly energy consumption is used for cooling from June throughout August (Figure 7).

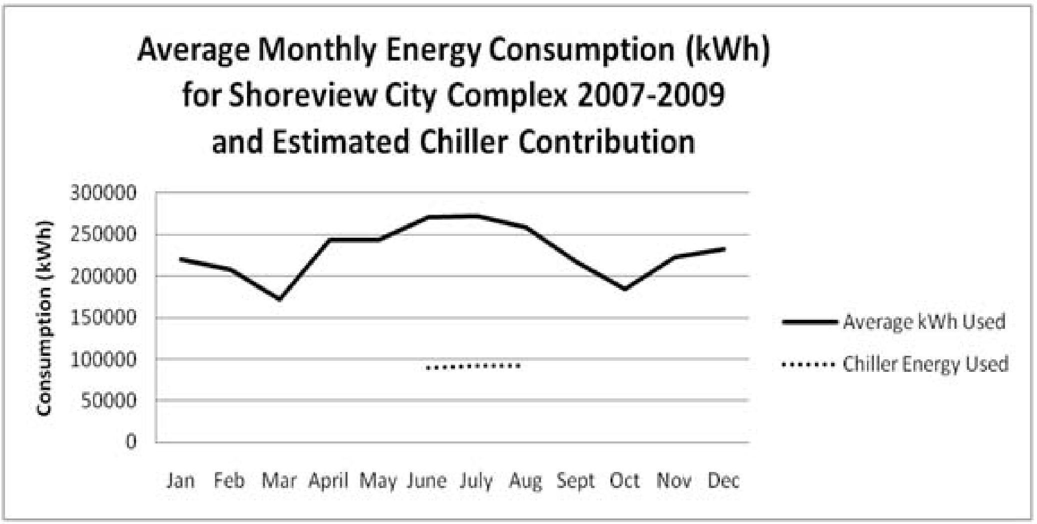

Figure 7. Average monthly energy consumption in kilowatt-hours of electricity over three years, the dotted line indicates the estimated total kilowatt-hours of electricity dedicated to cooling the building between the months of June–August (Data source: B3 Database, 2009).

Resident Perceptions of Energy Efficiency and Conservation in the Home

The following findings were compiled from responses given by Shoreview households in the *Our Household Choices in Urban Living* survey administered by a University of Minnesota research team in 2008 (Nelson et al. 2008). We analyzed questions regarding increasing the energy efficiency of a resident's home to better understand Shoreview household beliefs about energy efficiency and conservation in their own homes.

Shoreview residents perceive several barriers to increasing the energy efficiency of their homes. More than 65% of household survey respondents perceived potential difficulty of energy efficiency projects as a barrier (Figure 8). Concern about the possible expense of these projects was also considered likely or extremely likely by 66% of the respondents (Figure 9). Both the perceived difficulty and expense of the household energy efficiency projects may prevent homeowners from moving forward

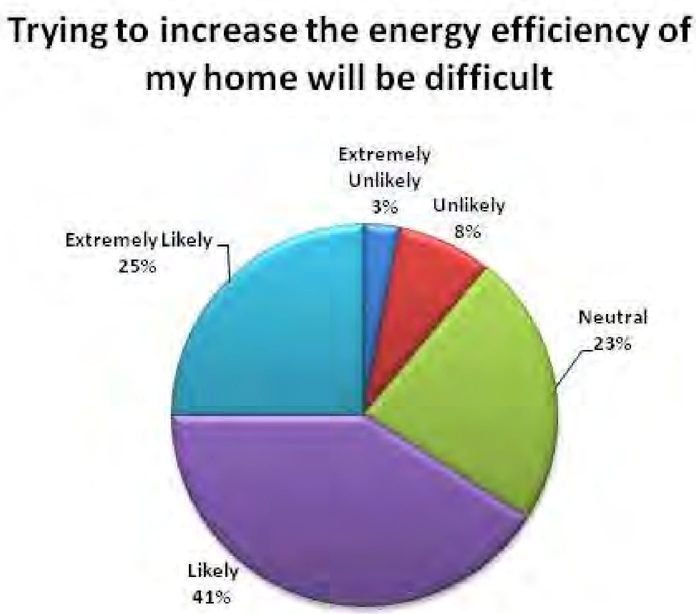

Figure 8. Shoreview respondents' answers to, "Considering household energy use rank the following statement: Trying to increase the energy efficiency of my home will be difficult," 5 pt. Likert-scale, (extremely likely=1 and extremely unlikely=5), (n= 109), 2008.

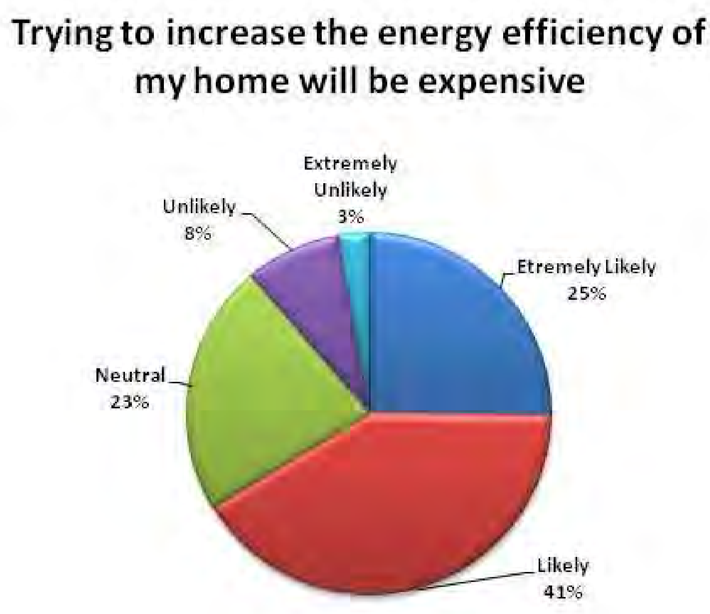

Figure 9. Shoreview respondents' answers to, "Considering household energy use rank the following: Trying to increase the energy efficiency of my home will require expensive changes," 5 pt. Likert-scale, (extremely likely=1 and extremely unlikely=5), (n= 109), 2008.

with their plans of energy efficiency. Of those who perceive energy efficiency projects to be difficult (likely or extremely likely), 91% also perceive it to be expensive (likely or extremely likely) (Figure 10).

The survey also revealed the strong moral obligation the respondents feel toward increasing their energy efficiency and that working to improve their energy efficiency would be better for the environment. In both cases well over half of the respondents believed it was their moral obligation to increase energy efficiency (66%) and understood that their household choices could benefit the environment (86%) (Figures 11 and 12). Findings from this analysis imply that efforts to reduce perceived barriers to energy efficiency actions such as difficultly and expense may increase resident likelihood to take action. At the same time, effective communication with residents about energy efficiency can help to reinforce feelings of moral obligation to increase the energy efficiency of their homes, as well as increase their understanding that these actions will be better for the environment.

Residential Energy Efficiency Projects and Funding Options

Residential energy efficiency projects and funding options are easy to locate on the internet. There are many great options for both local funding options provided solely for Minnesota residents, as well as funding options for alternative energy projects provided by the federal government (Appendix G). These options also range in cost from free, such as enrolling in the Xcel Energy Saver's Switch Program, to more expensive alternative energy options such as installing solar panels or geothermal electric systems (Table 8). There are a range of options for energy efficiency projects based on the ease of the project and the price. For most residents, there is likely an option that can fit their commitment to energy efficiency and their budget.

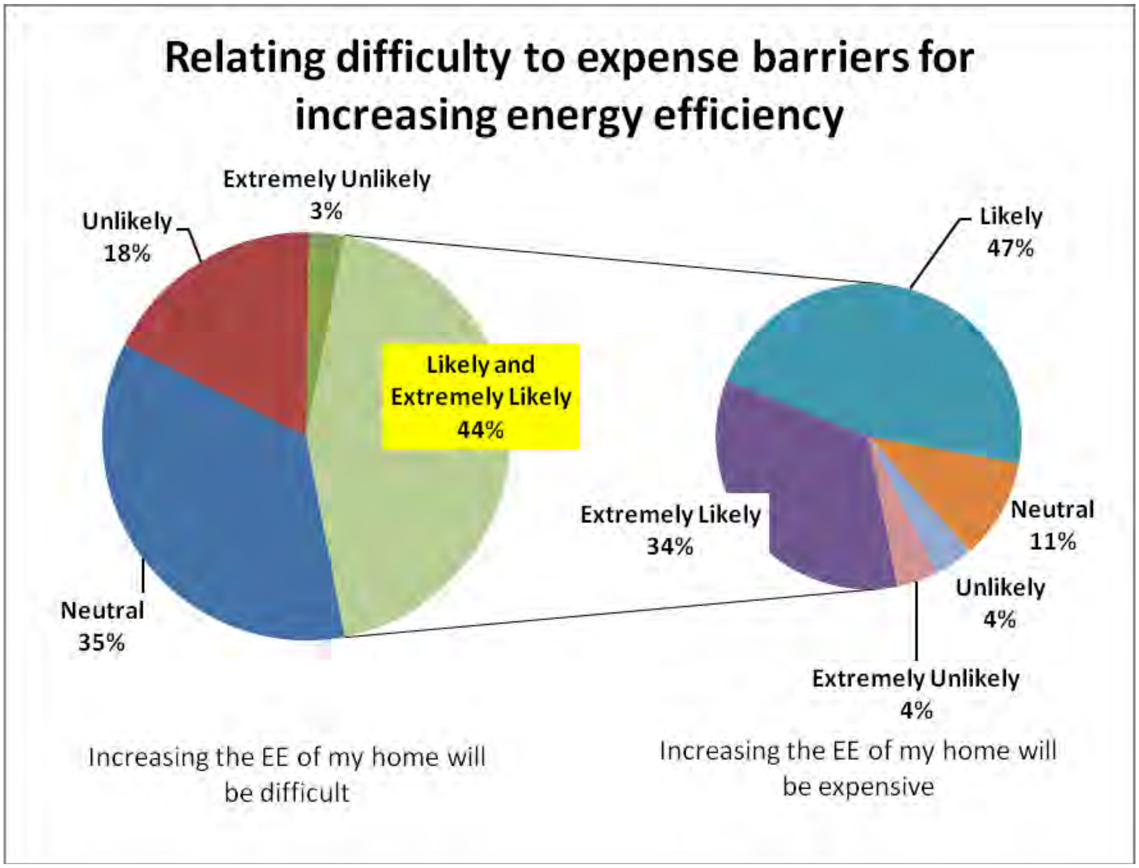

Figure 10. The pie graph on the left highlights the percentage of Shoreview respondents who answered likely and extremely likely to, "Considering energy use: Trying to increase the energy efficiency of my home will be difficult (5 pt. Likert scale, extremely likely=1 and extremely unlikely=5), (n= 109). The chart on the right displays the answers of those who perceive energy efficiency projects to be difficult, (likely or extremely likely), to the question "Considering energy use: Trying to increase the energy efficiency of my home will require expensive changes" (5 pt. Likert scale, extremely likely=1 and extremely unlikely=5), (n= 71), 2008.

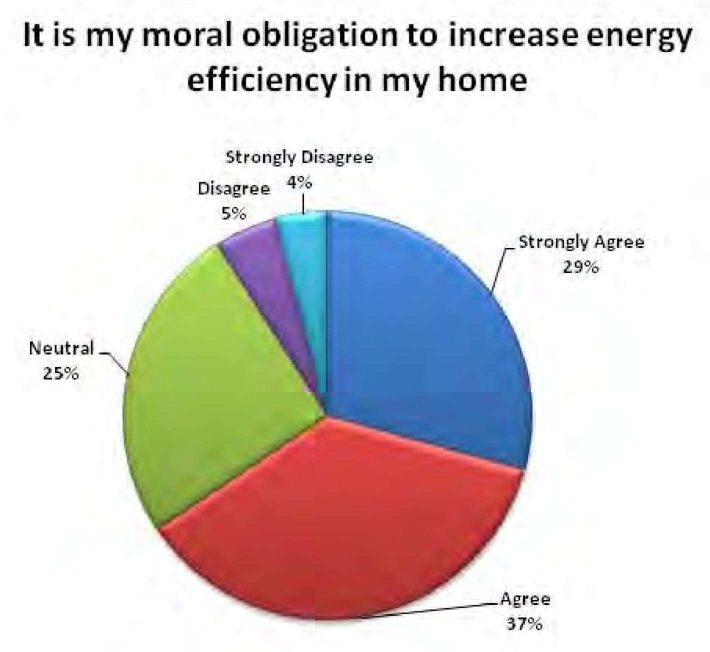

Figure 11. Shoreview respondents' answers to, "Considering household energy use rank the following statement: I think that it is my moral obligation to try to increase the energy efficiency of my home," 5 pt. Likert-scale, (extremely likely=1 and extremely unlikely=5), (n= 109), 2008.

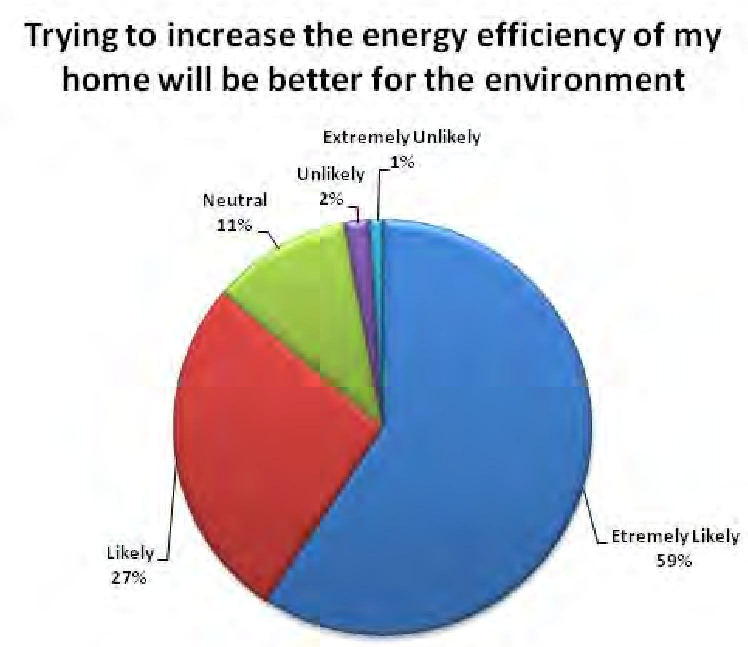

Figure 12. Shoreview respondents' answers to, "Considering household energy use rank the following statement: Trying to increase the energy efficiency of my home will be better for the environment," 5 pt. Likert-scale, (extremely likely=1 and extremely unlikely=5), (n= 109), 2008.

Table 8. Residential energy efficiency projects compared by cost, savings and energy savings.

Energy efficiency project	Up-front cost	Long-term savings	Energy savings	Household carbon emissions savings*
Compact fluorescent light (CFL) bulbs[1]	About $1.00 per bulb	About $50 per bulb in its lifespan	75% less energy use per bulb	NA
Xcel Energy Saver's Switch Program[2]	$0.00	About 15% on electric energy cost from June to September	Energy savings not available per household	NA
Xcel's Windsource Program[2]	Less than $25 per month for 100% wind power	$0.00	None--provides cleaner, renewable energy	BA
Solar Power	Varies per household	-Federal tax incentive of 40% for installation[3] costs - Exempt from sales and property taxes in Minnesota[3] -Minnesota's solar Electric Rebate Program offsets the cost of installtion[4]	None--provides cleaner, renewable energy	NA
Decreasing daytime thermostat by 1°F	Free	Save $15-$40 on average per heating season[5]		63.9 kg carbon/ year[8]
Installing programmable thermostat	Can cost as little as $30 depending on features[6]	Save 20% on heating costs[7]		141.5 kg carbon/ year[8]

* NA= Not Available

1. Bright Idea. *Responsible By Nature*. Xcel Energy, 2008. Web. 22 Sept. 2009. http://responsiblebynature.com/.
2. www.xcelenergy.com
3. Energy Info Center. *Minnesota Commerce: Renewable Energy Production Incentives*. Minnesota Department of Commerce, 2000. Web. 22 Sept. 2009. http://www.state.mn.us////content.do?id=-536881350&subchannel=-536881511&sc2=null&sc3=null&contentid=536885915&contenttype=EDITORIAL&programid=536885394&agency=Commerce.
4. Home Energy Loan Program. *Center for Energy and the Environment*. Center for Energy and the Environment, n.d. Web. 22 Sept. 2009. http://www.mncee.org/_residential/home_improvement_financing/_energy_loan_program/.php.
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7. 60 Simple ways to save money on your energy bill. *www.xcelenergy.com. Xcel Energy, 2006. Web. 4 Dec. 2009* http://www.xcelenergy.com/sitecollectionDocuments/docs/60_ways.pdf.
8. Nelson, K., L. Baker, D. Burk, C. Fissore, S. Hobbie, J. King, and J. McFadden. 2009. Preliminary Analysis of Twin Cities Household Ecosystem Survey: Household Energy Behavior and Carbon. TCHEP Project, University of Minnesota.

Recommendations

Improving energy efficiency in local government facilities and operations exemplifies environmental stewardship and responsible use of citizen tax dollars. If Shoreview can lead by example and use its resources wisely, it can motivate commercial and residential sectors to follow suit and foster a community-wide conversation about saving energy, money, and our precious environment. We recommend actions such as negotiating a flat rate for LED streetlights with Xcel and integrating LED upgrades into the maintenance schedule, as well as increasing the energy efficiency of the Shoreview City Complex, for Shoreview to demonstrate proactive leadership and showcase the benefits of energy efficiency and conservation to the city and the environment. Also, to promote public awareness and engagement, we recommend that Shoreview staff provide information to residents regarding projects and funding options for around the house.

Recommendation 1: Negotiate a Flat Rate for LED Streetlight Electricity Prices with Xcel Energy

Currently a major factor that restricts LED streetlights from being more economically feasible for Shoreview is the monthly meter service charge. Due to the high costs associated with boring wiring under driveways and other landscape obstacles, the City metered the five LED streetlights in its pilot project in two pairs, and one light by itself, resulting in monthly meter service charges that eliminated any energy cost savings gained from energy efficiency. Even though 50W LED streetlights use approximately 70% less energy than 175W MV streetlights, they must be metered with at least five other streetlights in order to have any savings in energy costs.

In order for LEDs to be widely introduced, a flat rate is necessary so the city does not pay upwards of 90% of total electricity costs on a metering charge, instead of on actual electricity consumption. When the metering charge is disregarded, modeling a scenario in which the city has negotiated a flat rate, there are significant annual electricity cost savings from upgrading to LEDs (Table 2). If one 175W MV streetlight is upgraded to a 50W LED that is metered with four other streetlights, there is an annual energy cost savings of $11.09. However, if the meter service charge is disregarded there is an annual energy cost savings of $30.30 (Appendix B.) To increase energy cost savings, the City of Shoreview could negotiate a flat rate for LED streetlights with the Public Utilities Commission and Xcel Energy. The city could also develop a plan to meter streetlights on a large scale in order to have the meter charge spread over more streetlights. Metering 16 streetlights together reduces the monthly metering service charge from $8 per streetlight to $0.53 per streetlight, which would generate considerable energy cost savings and would dramatically reduce the payback period for upgrading to LEDs (Appendix D).

LED streetlights offer sizeable energy use savings and resulting reductions in carbon emissions. The meter service charge is one barrier to the feasibility of upgrading to LEDs that could be avoided through negotiation with Xcel Energy or by metering higher quantities of lights to realize these potential economic and environmental benefits.

Recommendation 2: Monitor LED Fixture Prices and Integrate LED Upgrades Into the Maintenance Schedule for City-owned 175 W Mercury Vapor (MV) Streetlights

The City of Shoreview is considering LED streetlight technology as an alternative to their current Mercury Vapor (MV) and High Pressure Sodium (HPS) streetlights due to potential energy and maintenance cost savings, as well as reductions in carbon emissions. The city installed five LED streetlights as part of a pilot project, but emerging barriers may prevent the economic viability of widespread LED streetlights in Shoreview.

A major barrier to upgrading to LED streetlights is the price of LED fixtures, which are currently 4 times the cost of HPS fixtures. As with most cutting edge technologies, LED streetlights are expected to decrease in price as production volumes increase. It will be important for the City of Shoreview to monitor these prices and continually evaluate the economic viability of LEDs as prices change. A reduction in LED fixture costs will drastically shorten the payback period of an upgrade (Appendix B). As LED fixture costs decrease, the city should upgrade a larger percentage of MV streetlights to LEDs. If LED fixture costs decrease sufficiently, upgrading the city's 100W High Pressure Sodium (HPS) lights to LEDs will be more feasible (Appendix D). Shoreview can also monitor funding options for LED upgrades. Currently, or in the future, Shoreview may qualify for a number of grants to help fund LED projects. A number of cities including San Jose, CA, and Milwaukee, WI, are pursuing economic stimulus funds to upgrade their streetlights to LEDs (Keen 2009).

Disregarding the meter service charge, upgrading to 50W LEDs from 175W MV lights yields the largest annual energy cost savings among lighting technologies that the city is considering (Table 2). The city currently replaces all damaged MV streetlight fixtures with a slightly more efficient HPS streetlight fixture. Also exclusive of meter service charge, replacing a 175W MV streetlight with a 100W HPS light results in a 27 year payback period (Table 2). Similarly, if the city decided to upgrade an inoperable or damaged MV streetlight to a 50W LED the resulting payback period would be 36 years.

Damaged MV streetlights create a need for purchase and installation of new fixtures, increasing the economic viability of LEDs. In areas where MV streetlights or poles are damaged, the city could reduce energy use by installing LEDs. If a MV streetlight must be replaced, a 50W LED would recover its upfront cost in a period that is 11 years longer than the 100W HPS option, but at the same time LEDs reduce annual carbon emissions by 70%.

If the city were to upgrade all of its 175W MV streetlights to 50W LEDs it could reduce resulting annual carbon emissions by 39.5 metric tons; this is equivalent to the annual greenhouse gas emissions of 7.5 passenger vehicles. At current LED fixture prices, this project would cost over $140,000, making it very likely that funding options such as federal stimulus grants would be necessary to complete such a project. However, integrating 50W LED streetlight upgrades into the maintenance schedule when MV fixtures or poles are damaged provides a situation in which an LED upgrade is a long-term, cost-effective solution.

Recommendation 3: Increase Energy Efficiency of Shoreview City Complex

Energy use can account for as much as 10% of a local government's annual operating budget; electricity costs account for nearly 75% of that cost (US Department of Energy, 2009). In a time of financial challenge for state and local governments, many recognize increasing energy efficiency as an opportunity to reduce expenditures, yet government officials may perceive barriers to doing so.

Energy efficiency projects are not always difficult to implement and they produce multiple benefits. Oftentimes energy efficiency projects are shelved due to perceived barriers such as: lack of funding, lack of time or expertise to design and coordinate projects, or lack of personnel to implement projects properly. However, these are generally misconceptions; local governments can improve the energy efficiency of public buildings without raising citizen taxes or waiting until projects are scheduled into the budget. The first step in increasing the energy efficiency of the Shoreview City Complex is to identify and prioritize cost-effective building improvement options. For instance, replacing the chiller unit will save energy, reducing operating costs and carbon emissions. Once potential energy efficiency projects are identified, financing them is relatively easy; annual dollars saved by energy efficiency projects can be used to service the debt incurred from implementing these projects.

Order a Formal Energy Audit of the Building

A formal energy audit is a thorough electric-energy study of an entire facility done by an energy service provider or utility company. The result is a comprehensive listing of individual electric equipment types and their energy consumption characteristics followed by a cost/benefit analysis and recommendations for increasing energy efficiency where available. Our initial analysis and visual inspections of the City Complex indicated that there are opportunities for energy savings. A formal audit of the building would identify the fastest payback opportunities for retrofits or upgrades, help City Complex building managers and the Shoreview City Council make informed decisions about capital investments in this and other public buildings, as well as identify low and no-cost measures that have immediate energy and cost savings.

Explore Financing Options and Technologies for Energy Efficiency Projects in Publicly-Owned Buildings

Once Shoreview officials have determined the size of the investment required to implement priority energy efficiency projects, they can consider a range of financing options. Many states and utility providers administer programs that provide incentives for energy efficiency investments, but it is also possible to secure funding from external sources. An energy service performance contract, for example, can be used to implement energy efficiency upgrades at no upfront cost, through a financial arrangement with an energy service provider.

An energy service performance contract is an agreement between a local government and an energy service provider. The energy service provider identifies energy savings opportunities and recommends to officials the improvements that can be paid for by the energy savings (Zobler and Hatcher 2003). The company oversees the installation of projects and guarantees that energy savings will cover the cost of the project, consulting expenses, and up to 20 years of debt service on money the city borrows to pay for the projects (Adams 2009). In the public sector, this is called a guaranteed savings agreement.

Under Minnesota State Statute 471.345, the Uniform Municipal Contract Law subheading 13, ***Energy Efficiency Projects,*** pertains to training programs or facility alterations designed to reduce energy consumption or operating costs. Conceptually, this piece of legislation enables communities to undertake energy efficiency projects as a procurement method to address funding for capital projects through guaranteed savings agreements (Rykken 2009).

Guaranteed savings agreements generally seem intimidating to officials who think they appear too good to be true. Metro area cities such as Woodbury, Richfield, Eden Prairie, Anoka, and Brooklyn Park have already approved guaranteed savings contracts with energy service providers to implement energy efficiency programs. In Eden Prairie, energy savings are paying for the costs of about $2.5 million in ten-year bonds sold to finance the ice arena and other improvements (Adams 2009). Richfield has a $1.3 million contract to upgrade two ice rinks with high-efficiency heating and cooling systems. The cities have the option of using grants or their own funds to do other energy efficiency projects that are not covered by the agreements or to reduce the terms of the bond; Woodbury and Brooklyn Park did this (Adams 2009).

Local governments can overcome perceived barriers by outsourcing energy efficiency projects to qualified energy service providers and energy savings can be bundled to pay for auditing, equipment, maintenance, and energy costs (Zobler and Hatcher 2003). This can free up capital for other needs because the project costs are offset by long-term guaranteed savings. Also, a guaranteed savings contract is relatively risk-free because the performance contractor guarantees the savings to pay for the entire project, providing single-point accountability.

The City of St. Paul partnered with its utility provider to retrofit heating and cooling systems, replace street lighting and traffic signals, and implement other energy efficiency projects. These activities have saved the city nearly $8 million in energy costs annually and reduced its annual greenhouse gas emissions by more than 81,000 tons, equivalent to the annual emissions of 13,000 passenger vehicles (St. Paul, 2007).

The City of Shoreview could also benefit from a guaranteed energy savings contract to retrofit the heating and cooling systems of the City Complex. We identified in this report that the current electric water-cooled chiller system could be replaced with a model which uses half the energy.

The FEMP recommended efficiency of a water-cooled chiller is 0.59 kW/ton; by replacing the current unit with such a model, energy use and associated costs of operating the chiller could decrease by 60%. However, selecting a chilled-water system to perform efficiently under a variety of loads or conditions is more involved than just picking the most efficient chiller on the market. Total energy consumption, including energy associated with pumps and fans must be considered. Appropriate sizing of a chiller can also play a role in the performance of the system. An oversized chiller not only costs more upfront but also, poor part-load performance and excessive cycling yields increased energy losses. Also, control of secondary equipment such as fans can further optimize and increase the overall efficiency the building's cooling system. Tailoring a building automation control system to service only areas of the City Complex that need to be cooled (or heated) on a daily basis will save energy and money.

Investments to increase energy efficiency of publicly owned buildings not only reassures Shoreview constituents that tax dollars are being spent responsibly, but these projects also serve to showcase real-world applications of energy-efficient technologies.

Recommendation 4: Reduce Homeowner Perception of Barriers to Residential Energy Efficiency through Multimedia Methods

Reducing residential energy use will have the greatest positive influence on household carbon emissions and energy costs (Baker et al. 2006). The creation and distribution of energy efficiency solutions and funding options will prove to be beneficial for the Shoreview populous. Many homeowners perceive that cost and project difficulty are barriers to completing energy efficiency projects. Providing easy and affordable energy efficiency solutions can facilitate homeowners in moving forward with their desire to increase the energy efficiency of their homes. Multimedia methods for sharing this information would demonstrate to residents that city officials are committed to helping the residents achieve a more sustainable Shoreview.

Information gathered from the Household Choice Survey (Figures 8-11) suggests specific barriers that must be overcome as well as beliefs that support energy efficiency practices. A strong majority of respondents were interested in pursuing improved energy efficiency measures (91%), but thought that they would be both difficult and expensive (Figure 9). Were Shoreview to provide an easily accessible, easy to navigate and complete source of information for residents, the partnership could benefit the energy efficiency goal of Shoreview residents and city officials.

We created a Residential Energy Efficiency pamphlet that details possible projects, funding sources, and contacts for more information. The pamphlet addresses issues specific to Shoreview residents, informing them about the many options they have to create more energy efficient homes (Appendix H). An advantage of this pamphlet is that it can be updated easily and incorporated into the city of Shoreview website. This will provide a source of information for residents who are uncomfortable using the internet or are unaware of the resources available to them via internet sites.

Adding this residential energy efficiency information to the current Shoreview website is a possible option. This would serve as a central location where the completed pamphlet would be available in an electronic format, making it more widely accessible. In addition, the information could be updated by the City of Shoreview so those who access it will have the most up-to-date and relevant information. This information could be placed in the “Community Services” or “Environmental” sections of the City of Shoreview homepage, or in a unique, new webpage devoted solely to energy efficacy and conservation in Shoreview.

One challenge is developing the pamphlet, but this has already been addressed with a prototype pamphlet that Shoreview staff and officials may review and modify to fit their needs (Appendix H). Another disadvantage is that energy tools become outdated, this can be avoided by staff keeping the information provided up-to-date, checking for new grants and benefits, as well as cost projections. Multimedia offerings from the city of Shoreview regarding energy efficiency choices can help reinforce already held homeowner beliefs while reducing perceived barriers. The goal for the multimedia offerings, especially the pamphlet, is to remind residents of the virtues and benefits of pursuing energy efficiency options in their homes and provide them with possible solutions to do so.

Conclusions

In an age of economic recession and a changing ecological climate, it is important to remember that along with uncertainty comes opportunity. We cannot escape our energy consumption, but we can change it. In the United States, buildings–commercial and residential–account for 70% of electricity use and more than 38% of carbon emissions (Brown 2008; US Green Building Council 2007). Our changing society presents us with the challenge of doing what we do with less energy, doing it differently, or not doing it at all in order to conserve energy. The citizens of Shoreview identified energy conservation as a moral imperative; the first step in overcoming this challenge is making a personal commitment to change our energy consumption. City officials and staff have already begun projects to reduce energy use and costs. Through its active leadership and guidance, Shoreview has potential to be a model for citizens and cities across the nation. This project highlights ways in which the entire city of Shoreview can conserve or use energy more efficiently to battle the fluctuating costs of fossil fuels, dependence on foreign oil, and irreparable environmental damage.

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Appendix A. "Our Household Choices in Urban Living" Survey Questions Evaluated (Nelson et. al, 2008).

28. Considering energy use, please CIRCLE one response for each statement:

G. I think that it is my moral obligation to try and increase the energy efficiency of my home

Strongly Agree 1 2 3 4 5 Strongly Disagree

J. Trying to increase the energy efficiency of my home will require expensive changes

Extremely likely 1 2 3 4 5 Strongly Disagree

Trying to increase the energy efficiency of my home will be better for the environment

Extremely likely 1 2 3 4 5 Strongly Disagree

Trying to increase the energy efficiency of my home will be difficult

Extremely likely 1 2 3 4 5 Strongly Disagree

Appendix B. Payback Calculation of Upgrading One Streetlight from 175 MV and 100W HPS by Type, Ignoring Meter Service Charge, Shoreview, Minnesota, 2009.

Streetlight Type	50W LED	66W LED	100W LED	100W HPS	175W MV
Total Watts Consumed (W)	56.00	69.00	104.00	-	-
Avg. Hrs/Day	9.00	9.00	9.00	-	-
kWh/day	0.50	0.62	0.94	-	-
kWh/month	15.62	19.25	29.02	-	-
$/kWh (Jun-Sept Rate)	0.07	0.07	0.07	-	-
$/kWh (Oct-May Rate)	0.06	0.06	0.06	-	-
Electricity Cost/Month ($) (Summer)	1.05	1.29	1.95	-	-
Electricity Cost ($) (Summer)	4.19	5.16	7.78	-	-
Electricity Cost/Month ($) (Winter)	0.90	1.11	1.67	-	-
Electricity Cost ($)(Winter)	7.21	8.88	13.38	-	-
Electricity Cost ($) Flat Rate	-	-	-	24.00	35.16
Electricity Cost/yr ($)	11.40	14.04	21.16	24.00	35.16

Streetlight Type	50W LED	66W LED	100W LED	100W HPS	175W MV
Bulb Lifetime (yrs)	15.00	15.00	15.00	5.00	4.00
Bulb Disposal/yr ($)	-	-	-	0.39	0.49
Bulb Cost/yr ($)	-	-	-	1.45	2.29
Re-Lamping Labor Rate ($/hr)	-	-	-	60.00	60.00
Re-Lamping Labor (hr)	-	-	-	0.25	0.25
Re-lamping Labor/yr ($)	-	-	-	3.00	3.75
Total Annual Re-lamping Costs	0.00	0.00	0.00	4.84	6.54
Fixture Costs ($)	985.00	985.00	985.00	225.00	-
Upgrade Labor Rate ($/hr)	120.00	120.00	120.00	120.00	-
Upgrade Labor (hr)	1.00	1.00	1.00	1.00	-
Total Upgrade Cost ($)	1,105.00	1,105.00	1,105.00	345.00	-

Switching from 175W MV (One Streetlight)	50W LED	66W LED	100W LED	100W HPS
Annual Reduction in Electricity Usage (kWh)	440.19	397.49	282.51	229.95
Annual Electricity Cost Savings ($)	23.76	21.12	14.00	11.16
Annual Re-lamping Cost Savings ($)	6.54	6.54	6.54	1.69
Total Annual Cost Savings ($)	30.30	27.65	20.53	12.85
Total Upgrade Cost ($)	1,105.00	1,105.00	1,105.00	345.00
Payback Period (yrs)	36.47	39.96	53.82	26.85
Annual Reduction in Carbon Emissions (Metric tons)	0.32	0.29	0.20	0.17

Switching from 100W HPS (One Streetlight)	50W LED	66W LED	100W LED	175W MV
Annual Reduction in Electricity Usage (kWh)	210.24	167.54	52.56	-229.95
Annual Electricity Cost Savings ($)	12.60	9.96	2.84	-11.16
Annual Re-lamping Cost Savings ($)	4.84	4.84	4.84	-1.69
Total Annual Cost Savings ($)	17.45	14.80	7.68	-12.85
Total Upgrade Cost ($)	1,105.00	1,105.00	1,105.00	-
Payback Period (yrs)	63.33	74.65	143.89	-
Annual Reduction in Carbon Emissions (Metric tons)	0.15	0.12	0.04	-0.17

Assumptions:

- Disregarded Environmental Improvement Rider, Fuel Cost Charge, and Resource Adjustment charges Xcel Energy as they are applied to all types of streetlight
- Estimated streetlights used an average of 9 hrs/day
- Unsure about how many hours an upgrade would take, so made every upgrade a standard of one hour of labor
- Payback period does not take into account a discount rate
- Ignored other upgrade costs including $1,000 pole costs or wiring upgrades and boring costs
- Energy use for 100 HPS and 175 MV are estimates by city staff (Estimated 20 watts used in HPS fixture and 15 watts used in MV fixture)
- Assumed 15 minutes of labor for re-lamping (estimate by city staff)
- Assumed 15 year LED lifetime
- Bulb Replacement Costs: 100W HPS bulb cost = $7.25, 175W MV bulb cost = $9.17
- Used EPA factor of 0.000718 for metric tons of CO_2/kWh
- Another factor left out of these calculations is the bulb replacement cost for the LED streetlights. These lights are expected to last at least 15 and potentially 20+ years, so estimating the replacement costs at this time is not feasible considering these future prices are uncertain yet expected to decrease dramatically. As these calculations and streetlight related decisions are revisited in the future, it will be important to reconsider the potential LED replacement costs.

Appendix C. Calculation of Streetlight Upgrade Payback as LED Fixture Prices Decrease, Ignoring Meter Service Charge, Shoreview, Minnesota, 2009.

Switching from 175W MV (One Streetlight)	50W LED	66W LED	100W LED	100W HPS
Total Annual Cost Savings ($)	30.30	27.65	20.53	12.85
Total Upgrade Cost ($) (LED Fixture Current Price)	1,105.00	1,105.00	1,105.00	345.00
Total Upgrade Cost ($) (LED Fixture 75% of Current Price)	858.75	858.75	858.75	345.00
Total Upgrade Cost ($) (LED Fixture 50% of Current Price)	612.50	612.50	612.50	345.00
Total Upgrade Cost ($) (LED Fixtures 25% of Current Price)	366.25	366.25	366.25	345.00
Payback (LED Fixture Current Price)	36.47	39.96	53.82	26.85
Payback (LED Fixture 75% of Current Price)	28.34	31.05	41.83	26.85
Payback (LED Fixture 50% of Current Price)	20.22	22.15	29.83	26.85
Payback (LED Fixture 25% of Current Price)	12.09	13.24	17.84	26.85

Switching from 100W HPS (One Streetlight)	50W LED	66W LED	100W LED
Total Annual Cost Savings ($)	17.45	14.80	7.68
Total Upgrade Cost ($) (LED Fixture Current Price)	1,105.00	1,105.00	1,105.00
Total Upgrade Cost ($) (LED Fixture 75% of Current Price)	858.75	858.75	858.75
Total Upgrade Cost ($) (LED Fixture 50% of Current Price)	612.50	612.50	612.50
Total Upgrade Cost ($) (LED Fixture 25% of Current Price)	366.25	366.25	366.25
Payback (LED Fixture Current Price)	63.33	74.65	143.89
Payback (LED Fixture 75% of Current Price)	49.22	58.01	111.82
Payback (LED Fixture 50% of Current Price)	35.10	41.38	79.76
Payback (LED Fixture 25% of Current Price)	20.99	24.74	47.69

Appendix D. Total Annual Electricity Charges for One Streetlight by Streetlight Type Including Meter Service Charge, With Varying Number of Streetlights/Meter, Shoreview, Minnesota, 2009.

Electricity Costs for 1 Streetlight - Varying # lights/meter	50W LED	66W LED	100W LED	100W HPS	175W MV
Annual Electricity Usage (kWh)	183.96	226.67	341.64	394.20	624.15
Electricity Cost/yr ($) (Charged per kWh)	11.40	14.04	21.16	-	-
Electricity Cost/yr ($) (Charged Flat Rate)	-	-	-	24.00	35.16
Electricity Cost/yr ($)	11.40	14.04	21.16	24.00	35.16
Annual Metered Service Charge ($) ($96/meter) (1 light/meter)	96.00	96.00	96.00	-	-
Annual Metered Service Charge ($) ($96/meter) (3 lights/meter)	32.00	32.00	32.00	-	-
Annual Metered Service Charge ($) ($96/meter) (4 lights/meter)	24.00	24.00	24.00	-	-
Annual Metered Service Charge ($) ($96/meter) (5 lights/meter)	19.20	19.20	19.20	-	-
Annual Metered Service Charge ($) ($96/meter) (8 lights/meter)	12.00	12.00	12.00	-	-
Annual Metered Service Charge ($) ($96/meter (16 lights/meter)	6.00	6.00	6.00	-	-
Total Electricity Charges ($) (1 light/meter)	107.40	110.04	117.16	24.00	35.16
Total Electricity Charges ($) (3 lights/meter)	43.40	46.04	53.16	24.00	35.16
Total Electricity Charges ($) (4 lights/meter)	35.40	38.04	45.16	24.00	35.16
Total Electricity Charges ($) (5 lights/meter)	30.60	33.24	40.36	24.00	35.16
Total Electricity Charges ($) (8 lights/meter)	23.40	26.04	33.16	24.00	35.16
Total Electricity Charges ($) (16 lights/meter)	17.40	20.04	27.16	24.00	35.16

Appendix E. B3 Data: Shoreview City Complex Electricity Use 2007 – 2009, Minnesota.

Year	Month	Start	End	kWh	Peak kW	Total Cost	Cost per kWh
2007	Jan	1/2/2007	2/3/2007	222400	354	14,635.20	0.07
2007	Feb	2/3/2007	3/5/2007	207200	358	13,199.43	0.06
2007	March	3/5/2007	4/3/2007	118480	418	12,940.60	0.07
2007	April	4/3/2007	5/5/2007	204400	404	14,758.06	0.07
2007	May	5/5/2007	6/5/2007	240800	524	16,711.01	0.07
2007	June	6/4/2007	7/3/2007	275600	614	23,764.05	0.09
2007	July	7/3/2007	8/4/2007	314200	644	26,738.94	0.09
2007	Aug	8/4/2007	9/1/2007	254600	610	20,896.13	0.08
2007	Sept	9/1/2007	10/2/2007	221400	516	16,669.35	0.08
2007	Dec	12/3/2007	1/5/2008	249000	376	16,284.22	0.07
2008	Jan	1/5/2008	2/4/2008	227400	380	15,526.38	0.07
2008	Feb	2/4/2008	3/4/2008	214800	376	14,164.17	0.07
2008	Mar	3/4/2008	4/3/2008	215000	366	13,636.59	0.06
2008	Apr	4/3/2008	5/3/2008	237600	474	15,373.44	0.06
2008	May	5/3/2008	6/3/2008	258800	486	18,784.83	0.07
2008	June	6/3/2008	7/5/2008	286800	512	23,235.54	0.08
2008	July	7/5/2008	8/2/2008	267600	554	23,578.06	0.09
2008	Aug	8/2/2008	9/3/2008	281200	512	22,458.33	0.08
2008	Sept	9/3/2008	10/4/2008	212600	436	15,643.92	0.07
2008	Oct	10/4/2008	11/1/2008	184400	456	12,955.04	0.07
2008	Nov	11/1/2008	12/3/2008	222800	405	15,455.46	0.07
2008	Dec	12/3/2008	1/4/2009	215200	348	13,854.71	0.06
2009	Jan	1/4/2009	2/4/2009	208800	346	13,670.13	0.07
2009	Feb	2/4/2009	3/7/2009	202800	332	13,605.80	0.07
2009	Mar	3/7/2009	4/5/2009	181800	342	13,010.95	0.07
2009	Apr	4/5/2009	5/5/2009	208600	410	14,018.08	0.07
2009	May	5/5/2009	6/6/2009	230600	468	16,213.48	0.07
2009	June	6/6/2009	7/6/2009	250800	534	20,379.60	0.08

2009	July	7/6/2009	8/4/2009	234800	472	19,041.05	0.08
2009	Aug	8/4/2009	9/2/2009	239800	492	19,849.75	0.08

Appendix F. B3 Data: Shoreview City Complex Natural Gas Use 2007 – 2009, Minnesota.

Area	Year	Start	End	Month	Therms	Total Cost	Cost per Therm
Main Bldg	2007	1/7/2007	2/5/2007	Jan	480	507.63	1.06
Main Bldg	2007	2/5/2007	4/4/2007	Feb	13893	14,637.39	1.05
Main Bldg	2007	4/4/2007	5/6/2007	Apr	4079	3,877.14	0.95
Main Bldg	2007	5/6/2007	6/5/2007	May	1420	1,486.71	1.05
Main Bldg	2007	6/5/2007	7/5/2007	Jun	848	893.66	1.05
Main Bldg	2007	7/5/2007	8/5/2007	Jul	851	811.52	0.95
Main Bldg	2007	8/5/2007	9/4/2007	Aug	748	650.81	0.87
Main Bldg	2007	9/4/2007	10/3/2007	Sep	863	694.82	0.81
Main Bldg	2007	12/4/2007	1/7/2007	Dec	7354	9,300.03	1.26
Main Bldg	2008	1/7/2008	2/5/2008	Jan	6753	8,422.21	1.25
Main Bldg	2008	2/5/2008	3/5/2008	Feb	7365	9,688.23	1.32
Main Bldg	2008	3/5/2008	4/6/2008	Mar	4948	7,083.34	1.43
Main Bldg	2008	4/6/2008	5/5/2008	Apr	3126	4,439.01	1.42
Main Bldg	2008	5/5/2008	6/4/2008	May	1260	2,072.93	1.65
Main Bldg	2008	6/4/2008	7/6/2008	Jun	828	1,399.73	1.69
Main Bldg	2008	7/6/2008	8/4/2008	Jul	857	1,229.65	1.43
Main Bldg	2008	8/4/2008	9/4/2008	Aug	600	793.82	1.32
Main Bldg	2008	9/4/2008	10/5/2008	Sep	1013	966.09	0.95
Main Bldg	2008	10/5/2008	11/3/2008	Oct	2466	2,396.15	0.97
Main Bldg	2008	11/3/2008	12/4/2008	Nov	5089	5,906.58	1.16
Main Bldg	2008	12/4/2008	1/7/2009	Dec	9692	9,958.08	1.03

Main Bldg	2009	1/7/2009	2/5/2009	Jan	8982	9,039.09	1.01
Main Bldg	2009	2/5/2009	3/8/2009	Feb	7528	6,355.04	0.84
Main Bldg	2009	3/8/2009	4/6/2009	Mar	5651	4,316.64	0.76
Main Bldg	2009	4/6/2009	5/6/2009	Apr	2705	1,791.21	0.66
Main Bldg	2009	5/6/2009	6/7/2009	May	1437	887.39	0.62
Main Bldg	2009	6/7/2009	7/7/2009	Jun	990	573.47	0.58
Main Bldg	2009	7/7/2009	8/4/2009	Jul	882	544.57	0.62
Main Bldg	2009	8/4/2009	9/3/2009	Aug	849	513.25	0.6
Pool	2006	12/4/2006	1/7/2007	Dec	8608	10308.73	1.2
Pool	2007	1/7/2007	2/5/2007	Jan	8914	9016.71	1.01
Pool	2007	2/5/2007	3/6/2007	Feb	7594	7992.19	1.05
Pool	2007	3/6/2007	4/4/2007	Mar	3546	3767.05	1.06
Pool	2007	4/4/2007	5/6/2007	Apr	3807	3638.74	0.96
Pool	2007	5/6/2007	6/5/2007	May	2697	2781.05	1.03
Pool	2007	6/5/2007	7/5/2007	Jun	2184	2226.77	1.02
Pool	2007	7/5/2007	8/5/2007	Jul	2140	1968.74	0.92
Pool	2007	8/5/2007	9/4/2007	Aug	2038	1690.58	0.83
Pool	2007	9/4/2007	10/3/2007	Sep	3658	2791.71	0.76
Pool	2007	12/4/2007	1/7/2008	Dec	5419	6296.61	1.16
Pool	2008	1/7/2008	2/5/2008	Jan	4233	4860.7	1.15
Pool	2008	2/5/2008	3/5/2008	Feb	4236	5131.41	1.21
Pool	2008	3/5/2008	4/6/2008	Mar	4177	5486.59	1.31
Pool	2008	4/6/2008	5/5/2008	Apr	3297	4304.59	1.31
Pool	2008	5/5/2008	6/4/2008	May	3402	5068.59	1.49

Pool	2008	6/4/2008	7/6/2008	Jun	2435	3702.87	1.52
Pool	2008	7/6/2008	8/4/2008	Jul	2010	2826.7	1.41
Pool	2008	8/4/2008	9/4/2008	Aug	2099	2454	1.17
Pool	2008	9/4/2008	10/5/2008	Sep	3311	3129.69	0.95
Pool	2008	10/5/2008	11/3/2008	Oct	3131	2790.8	0.89
Pool	2008	11/3/2008	12/4/2008	Nov	4666	4961.2	1.06
Pool	2008	12/4/2008	1/7/2009	Dec	7200	7408.72	1.03
Pool	2009	1/7/2009	2/5/2009	Jan	5981	6026.14	1.01
Pool	2009	2/5/2009	3/6/2009	Feb	5568	4694.04	0.84
Pool	2009	3/6/2009	4/6/2009	Mar	4178	3198.99	0.77
Pool	2009	4/6/2009	5/6/2009	Apr	3453	2265.92	0.66
Pool	2009	5/6/2009	6/7/2009	May	2137	1299.66	0.61
Pool	2009	6/7/2009	7/7/2009	Jun	1236	706.85	0.57
Pool	2009	7/7/2009	8/6/2009	Jul	1274	767.13	0.6
Pool	2009	8/6/2009	9/3/2009	Aug	1133	669.91	0.59
Fitness Center	2006	12/4/2006	1/7/2007	Dec	3457	4146.8	1.2
Fitness Center	2007	1/7/2007	2/5/2007	Jan	5023	5086.74	1.01
Fitness Center	2007	2/5/2007	3/6/2007	Feb	4035	4246.5	1.05
Fitness Center	2007	3/6/2007	4/4/2007	Mar	2140	2265.03	1.06
Fitness Center	2007	4/4/2007	5/6/2007	Apr	1966	1868.83	0.95
Fitness Center	2007	5/6/2007	6/5/2007	May	709	742.68	1.05
Fitness Center	2007	6/5/2007	7/5/2007	Jun	273	296.3	1.09
Fitness Center	2007	7/5/2007	8/5/2007	Jul	601	563.63	0.94
Fitness Center	2007	8/5/2007	9/4/2007	Aug	729	612.05	0.84

Fitness Center	2007	9/4/2007	10/3/2007	Sep	820	639.06	0.78
Fitness Center	2007	12/4/2007	1/7/2008	Dec	6007	6955.07	1.16
Fitness Center	2008	1/7/2008	2/5/2008	Jan	5281	6029.72	1.14
Fitness Center	2008	2/5/2008	3/5/2008	Feb	3674	4431.74	1.21
Fitness Center	2008	3/5/2008	4/6/2008	Mar	2805	3682.87	1.31
Fitness Center	2008	4/6/2008	5/5/2008	Apr	1738	2257.93	1.3
Fitness Center	2008	5/5/2008	6/4/2008	May	917	1375.64	1.5
Fitness Center	2008	6/4/2008	7/6/2008	Jun	1010	1539.01	1.52
Fitness Center	2008	7/6/2008	8/4/2008	Jul	972	1368.12	1.41
Fitness Center	2008	8/4/2008	9/4/2008	Aug	896	1047.43	1.17
Fitness Center	2008	9/4/2008	10/7/2008	Sep	953	880.53	0.92
Fitness Center	2008	10/7/2008	11/5/2008	Oct	1498	1340.33	0.89
Fitness Center	2008	11/5/2008	12/4/2008	Nov	3160	3361.24	1.06
Fitness Center	2008	12/4/2008	1/4/2009	Dec	5448	5592.91	1.03
Fitness Center	2009	1/4/2009	2/5/2009	Jan	5467	5511.66	1.01
Fitness Center	2009	2/5/2009	3/6/2009	Feb	4124	3482.47	0.84
Fitness Center	2009	3/6/2009	4/6/2009	Mar	3140	2402.91	0.77
Fitness Center	2009	4/6/2009	5/6/2009	Apr	1324	877.83	0.66
Fitness Center	2009	5/6/2009	6/7/2009	May	1104	670.8	0.61
Fitness Center	2009	6/7/2009	7/7/2009	Jun	987	551.03	0.56
Fitness Center	2009	7/7/2009	8/6/2009	Jul	720	431.22	0.6
Fitness Center	2009	8/6/2009	9/3/2009	Aug	730	425.91	0.58

Appendix G. Energy Efficiency Funding Options, Shoreview, Minnesota, 2009.

Several energy efficiency project funding options for the Shoreview residents:

1. Purchase of Compact Fluorescent light (CFL) bulbs from local home improvement stores
   a. These bulbs use 75% less energy per bulb and have a life span of up to 15,000 hours. If properly used a CFL light bulb can save up to $50 during its life span.
2. Enroll in the Xcel Energy Saver's Switch Program
   a. Allows residents to save up to 15% on electric energy costs from June to September each year
3. Enroll in Windsource Program through Xcel Energy
   a. The typical home uses between 600 and 1,000 KWh of electricity per month. You choose how much of your power you want supplied by wind by selecting a number of blocks or by choosing the 100% Windsource option. It will cost you less than $25 per month to power your home with 100% wind energy.
4. Install solar power in a residential home
   a. Federal Tax incentive of 30% (no cap) of the cost of having a solar electric system installed before December 31st, 2016
   b. Minnesota exempts solar systems from sales and property taxes
   c. Minnesota's Solar Electric Rebate Program
      i. Provides rebates for photovoltaic systems that offset the costs of installing new solar electric systems on houses. The application must be approved prior to installation.
      ii. Application can be found at www.energy.mn.gov

Appendix H. Prototype Pamphlet for Shoreview Residents.

Why is increasing energy efficiency?

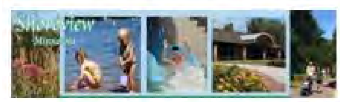
Shoreview is a leader in Minnesota environmental efforts in energy conservation and reduction, but to truly address these issues requires a community effort. It is important for the residents of Shoreview to take on responsibility for the energy consumption of the city.

Over 75% of Shoreview Residents surveyed believed increasing the energy efficiency of their homes would be beneficial for the environment. Shoreview citizens know the importance of protecting the environment, and value the quality of life it provides.

This pamphlet offers energy efficiency projects that can be used in your own home and funding options for residential solar power, so that each of you can begin doing your part to decrease energy use in our city and protect the environment that is so dear to Shoreview.

Shoreview Residential Energy Conservation

Easy Ideas for Home Energy Conservation that Save Money and Benefit the Environment



Easy Energy Efficiency

In a survey given to Shoreview households, over 65% of the respondents believed it would be difficult to increase the energy efficiency of their home, but with these easy energy reduction projects everyone can make a change.

Purchase Compact Fluorescent light (CFL) bulbs from local home improvement stores

CFL bulbs use 75% less energy per bulb and last up to 15,000 hours. If properly used, a CFL light bulb can save up to $50 during its life span as compared to incandescent bulbs, and Xcel Energy customers can buy them for as little as $1 per bulb.

Enroll in Xcel Energy's "Saver's Switch" Program

By remote control, Xcel will run your air conditioner in 15 minute on/off cycles. Xcel activates Saver's Switch for 10-15 of the hottest days each summer from June-Sept. Most residents do not notice a difference in temperature, and enrolled residents can save up to 15% on electric energy costs from June to September. Enroll online at www.xcelenergy.com.

Enroll in the Windsource Program through Xcel Energy

The typical Shoreview home uses about 7,400 KWh of electricity monthly. You can choose how much of your power you want supplied by wind by selecting a number of KWh blocks. It can cost as little as $25 more per month to power your home with 100% wind energy.

Funding Options for Alternative Energy Projects

Shoreview has great solar energy potential in many of the residential areas, but installing solar panels is often too expensive for residents to fund on their own. Solar power will help save electricity and money in the long run. The following are grants, tax breaks and other funding options for residential solar power that can help offset the initial costs.

Install solar power in a residential home

- There is a federal tax incentive of 30% of the cost for a solar electric system, installed before December 31st, 2016.
- Minnesota exempts solar systems from sales and property taxes, helping to reduce the costs associated with the installation.
- Minnesota's Solar Electric Rebate Program:

Rebates for photovoltaic systems offset installation costs of new solar electric systems. The application must be approved prior to installation and can be found at www.energy.mn.gov

For more Energy Saving Ideas and Information:
- www.xcelenergy.com
- www.energy.mn.gov
- http://www.energystar.gov
- http://www.energysavers.gov
- http://www.earthshare.org

For More Alternative Energy Information and Options:
- http://www.altestore.com
- http://www.dsireusa.org

Photo Credits and References:
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- http://[illegible].files.wordpress.com/2008/12/house.jpg
- http://[illegible].org/wp-content/uploads/2008/06/green-business.jpg

Top (L-R): Inside flap, back, cover. **Bottom (L-R):** Three inside flaps.